Impact of Asian aerosols on precipitation over California: An observational and model based approach

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Dust and pollution emissions from Asia are often transported across the Pacific Ocean to over the western United States. Therefore, it is essential to fully understand the impact of these aerosols on clouds and precipitation forming over the eastern Pacific and western United States, especially during atmospheric river events that account for up to half of California's annual precipitation and can lead to widespread flooding. In order for numerical modeling simulations to accurately represent the present and future regional climate of the western United States, we must account for the aerosol-cloud-precipitation interactions associated with Asian dust and pollution aerosols. Therefore, we have constructed a detailed study utilizing multi-sensor satellite observations, NOAA-led field campaign measurements, and targeted numerical modeling studies where Asian aerosols interacted with cloud and precipitation processes over the western United States. In particular, we utilize aerosol optical depth retrievals from the NASA Moderate Resolution Imaging Spectroradiometer (MODIS), NOAA Geostationary Operational Environmental Satellite (GOES-11), and Japan Meteorological Agency (JMA) Multi-functional Transport Satellite (MTSAT) to effectively detect and monitor the trans-Pacific transport of Asian dust and pollution. The aerosol optical depth (AOD) retrievals are used in assimilating the Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) in order to provide the model with an accurate representation of the aerosol spatial distribution across the Pacific. We conduct WRF-Chem model simulations of several cold-season atmospheric river events that interacted with Asian aerosols and brought significant precipitation over California during February-March 2011 when the NOAA CalWater field campaign was ongoing. The CalWater field campaign consisted of aircraft and surface measurements of aerosol and precipitation processes that help extensively validate our WRF-Chem model simulations. After validating the capability of the WRF-Chem in realistically simulating the aerosol-cloud-precipitation interactions, we conduct sensitivity studies where the AOD is doubled to diagnose whether an increasing concentration of Asian aerosols over the western United States will lead to further impacts on the cloud and precipitation processes over California. We also perform sensitivity studies where the aerosols will be partitioned into dust-only and pollution-only in order to separate the impacts of the differing Asian aerosol species. The results of our WRF-Chem model simulations aim to show that the trans-Pacific transport of Asian aerosols influence the precipitation associated with atmospheric river events that can ultimately impact the regional climate of the western United States.

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